Global Ocean Internal Wave Database

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LONG-TERM GOALS

Our long-term goal is to develop a global database of ocean internal waves observed primarily from spacecraft. This database will be publicly accessible and can be used for various purposes including understanding the statistical properties of internal waves and upper ocean dynamics in any ocean area of interest.

OBJECTIVES

Our objectives are to extract information on ocean internal waves from Space Shuttle photographs and satellite SAR, to construct a database containing the information for global oceans and to make the database publicly accessible via the Internet. We demonstrate the use of the database by performing statistical analyses of internal wave features and dynamic analysis of their evolution under continental shelf boundary conditions.

APPROACH

The global database of ocean internal waves has two major sections, one for Space Shuttle images and a separate section containing SAR imagery from ERS-1, 2, Radarsat, and other spacecraft. The images are accompanied by interpretation maps and text describing oceanographic properties of the imaged features. The database includes a home page, offers a standard format and is accessible to Internet users.

Report Documentation Page

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14. ABSTRACT
Our long-term goal is to develop a global database of ocean internal waves observed primarily from spacecraft. This database will be publicly accessible and can be used for various purposes including understanding the statistical properties of internal waves and upper ocean dynamics in any ocean area of interest.

15. SUBJECT TERMS

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WORK COMPLETED

We added 155 new images of ocean internal waves (105 SAR images and 50 space shuttle photographs) to the database. Among them, 40 cases were interpreted with maps and texts. The newly added cases, distributed globally, increase the total number of cases in the database to 355, and the interpreted cases to 82. We incorporated a new search method "clickmap" into the database. Application of this user-friendly technology helps users to more easily enter the database and find the data they look for. We also continued our demonstration study for using the database. We completed research and development of methods for determining ocean internal wave characteristic half-widths using SAR images. The results have been delivered to the NOAA/NESDIS Office of Research and Applications SAR Project, where they are being used to estimate the thermocline depth in fisheries applications. Using our research results, we published three new papers in scientific journals and gave three presentations at international conferences. (see Publications)

RESULTS

An updated map of the global distribution of ocean internal wave cases in the expanded database is shown in Figure 1. An updated entry page with the newly adopted "clickmap" search method is shown in Figure 2. From here users can easily browse the whole database using their own machines.

We developed new techniques for interpreting satellite SAR images of ocean internal waves. We derived an analytical expression for a radar image of an ocean internal soliton. We validated the theoretical model using ocean internal wave signals taken from ERS-1 SAR and Radarsat SAR images archived in the database. The results indicate that the model perfectly simulates ocean internal soliton signatures with double sign variations of radar backscatter. Using these results, we developed curve fitting peak-to-peak methods for determining the internal soliton characteristic half-width, which is a key parameter for calculating the internal soliton amplitude. Tests indicate that ocean internal soliton amplitudes derived by the two methods agree with field measurements within reasonable accuracy. These results have potential applications in various fields.

IMPACT/APPLICATION

When completed, this Internet-accessible database will represent the largest collection of internal wave imagery observed by spacecraft over most of the globe. The sample size will be large enough for scientists to evaluate the general statistical properties of internal waves in various parts of the oceans. Furthermore, it will be possible to test models and obtain detailed descriptions of internal waves at specific ocean sites.

TRANSITIONS

Scientists from various institutions have already requested imagery from our internal wave database. Eight papers using the data from this database have been published in scientific journals and at conferences.

RELATED PROJECTS

We have been working closely with various investigators, including Chris Jackson (Dr. John Apel's assistant at Global Ocean Associates), Dr. Antony Liu (NASA/GSFC), Tim Donato (NRL), et al. who have provided us with SAR imagery and performed some of the internal wave analyses.

PUBLICATIONS

Klemas, V., Q. Zheng, and X.-H. Yan, 2000. Space Shuttle Studies of Ocean Internal Waves. Proc. Sixth Int. Conf. on Remote Sensing for Marine and Coastal Environments, Charleston, SC, May 1-3, 2000.

Zheng, Q., X.-H. Yan, W. T. Liu, and V. Klemas, 2000. Solitary Waves in the Atmosphere and Ocean Observed from Space, Overseas Chinese Ocean-Atmosphere Remote Sensing Workshop, Hong Kong, China, July 6-7, 2000.

Zheng, Q., V. Klemas, X.-H. Yan, and J. Pan, 2000. Nonlinear Evolution of Ocean Internal Solitons Propagating along an Inhomogeneous Thermocline, *J. Geophys. Res*., 106, 14,083-14,094, 2001.

Zheng, Q., X.-H. Yan, W. T. Liu, and V. Klemas, 2000. Space Shuttle Observations of Open Ocean Oil Slicks, Remote. Sensing of Environment, *Rem. Sens. Environ.,*76, 49-56, 2001.

Klemas, V., Q. Zheng, X.-H, Yan. 2001. Ocean Internal Wave Observations Using Space Shuttle and Satellite Imagery. *Geocarto International,* 16(2), 51-55.

Zheng, Q., Y. Yuan, V. Klemas, X.-H. Yan. 2001. Theoretical expression for an ocean internal soliton SAR image and determination of the soliton characteristic hald width, *J. Geophys, Res.,* 106, 31,415-31,423.

Zheng, Q., V. Klemas, X.-H. Yan. Advance in studies of ocean internal waves observed from space, *Recent Research Developments I Geophysics,* Research Signpost, 2002 in press.

Klemas, V., Q. Zheng, X.-H. Yan. Space Shuttle and Satellite Observations of Ocean Internal Waves. *Proc. 7th International Conference on Remote Sensing for Marine and Coastal Environments,* Miami, FL, May 20-22, 2002.

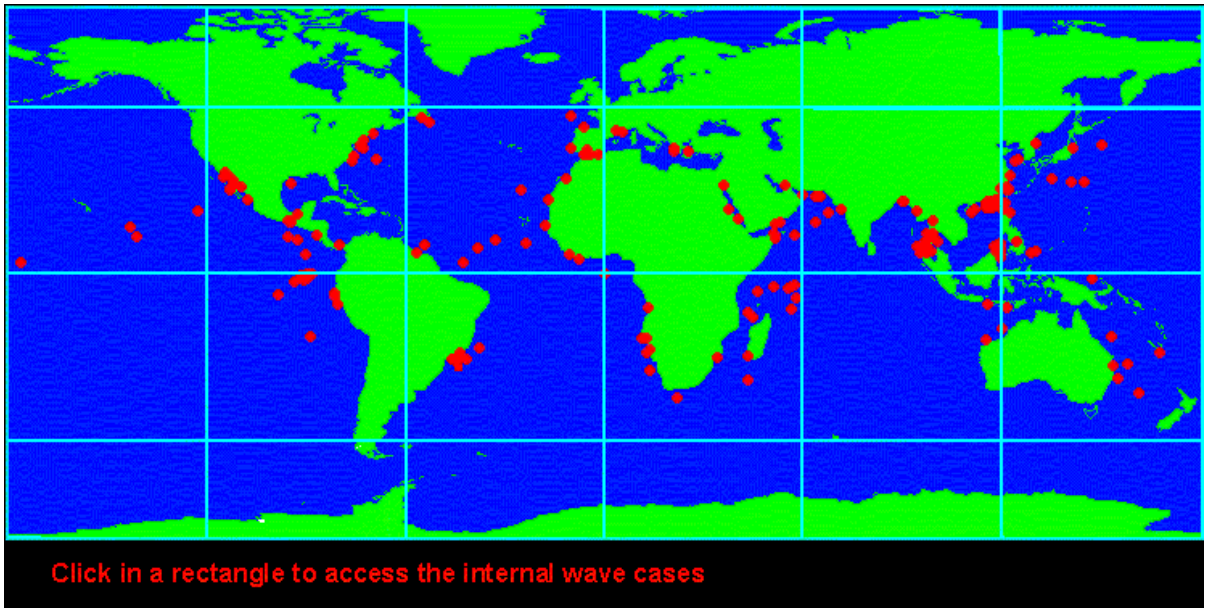

Figure 1 Distribution map of internal wave cases

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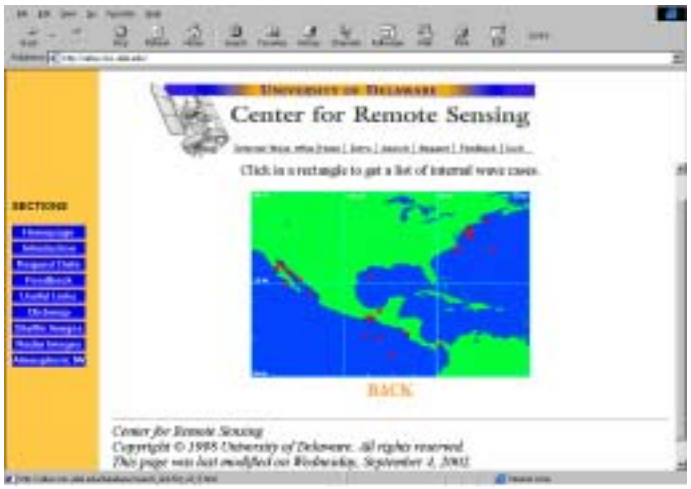

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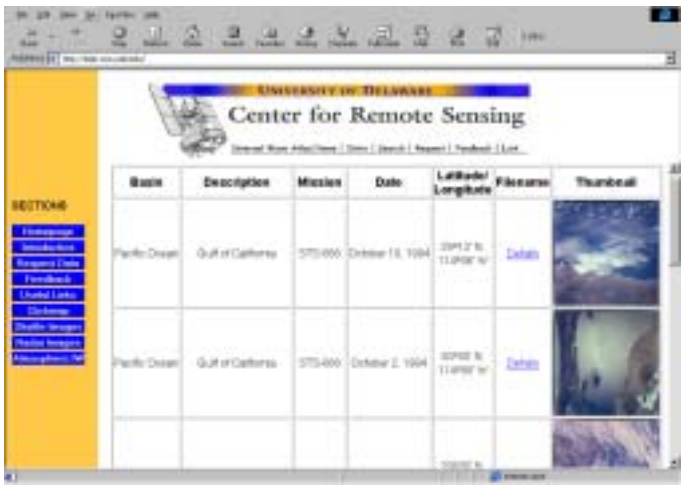

Figure 2 Clickmap search method